TECHNICAL SESSION 1: Manufactured Soil A

Charles R. Lee, PhD, Chair

THE CONCEPT OF MANUFACTURING SOIL FROM DREDGED MATERIAL BLENDED WITH ORGANIC WASTE MATERIALS AND BIOSOLIDS

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Fertile soil can be manufactured from recycled materials that can include dredged material, organic waste materials and biosolids. All dredged material can be used to manufacture soil, however, some dredged material may require reconditioning to some extent, depending on the circumstances. Organic waste materials could include just about anything, such as sawdust from lumber processing, bagasse from sugar cane processing, yard waste, paper processing cellulose mud, waste paper, hurricane debris, *Phragmites*, or *Melaleuca* compost.

Biosolids can be derived from reconditioned municipal sewage sludge, reconditioned cow manure, chicken manure, or reconditioned pig manure. The ingredients will depend on what is available in close proximity. These ingredients can be blended according to a patented formulation, tested in greenhouse screening experiments and demonstrated at field locations. The development of this technology has been possible through Cooperative Research and Development Agreements between US Army Corps of Engineers (Corps), Waterways Experiment Station (WES) and commercial entities such as TERRAFORMS, N-Viro International, Bion Technologies, Inc. and Scotts Company.

Together, each participant contributes to the demonstration of manufactured soil technology and eventually to the commercialization of the process. Specific examples will be discussed in detail in other companion papers at this workshop.

MANUFACTURED SOIL FROM TOLEDO HARBOR DREDGED MATERIAL AND ORGANIC WASTE MATERIALS

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Manufactured soil was evaluated in greenhouse screening tests and demonstrated at Toledo, OH using dredged material, organic waste material and biosolids. Greenhouse screening tests evaluated germination and growth of four plant species: ryegrass, tomato, marigold, and vinca. Various blends of dredged material ranging from 40 to 80 percent, and organic waste materials (sawdust, yard waste)ranging from 10 to 50 percent, and biosolids at 10 percent.

Based on results of the screening tests, a demonstration was conducted to produce 660 cu yd of manufactured soil. The manufactured soil was used to landscape the front entrance to the University of Toledo and the Toledo Botanical Garden. The demonstration was a cooperative effort among the City of Toledo, Toledo Port Authority, CRDA partners (Terraforms and N-Viro), the Corps Buffalo District and WES, and was an overwhelming success. The Buffalo District supplied the dredged material and funded the demonstration. The Port Authority located potential demonstration sites to receive the manufactured soil. Terraforms supplied the patented formula, and manpower to locate blending equipment for the demonstration and onsite technical support. N-Viro International supplied the biosolids for the manufactured soil. WES coordinated all activities for the demonstration. The City of Toledo supplied dump trucks to haul manufactured soil from the processing site at the Corps' Cell 1 confined disposal facility (CDF) to the University of Toledo and to Toledo Botanical Garden.

Commercialization of the manufacture of soil products with up to 800,000 cu yd of dredged material per year has been proposed by Terraforms and interested local entities. At that rate, the existing CDF will be available for accepting dredged material from the Toledo Harbor just about the time the newly constructed CDF will be filled to capacity.

MANUFACTURED SOIL FROM CONTAMINATED NEW YORK/NEW JERSEY HARBOR DREDGED MATERIAL

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Manufactured soil was produced from New York/New Jersey Harbor fresh anaerobic dredged material and organic waste materials. Greenhouse screening tests were conducted with various blends ranging from 30-80 percent dredged material, 10-60 percent organic waste (sawdust, yard waste), and 10 percent biosolids (Bionsoil[R]). Greenhouse screening tests results indicated that a manufactured soil blend could grow grass. The other plant species could not tolerate the salt content of the blend.

A demonstration was conducted at the Port of Newark in which manufactured soil was blended and three different phytoremediation approaches were tested. Phytoremediation I consisted of plant species to contain contaminants within the dredged material. Phytoremediation II consisted of a plant species to remove metals from the dredged material. Phytoremediation III consisted of plant species to biodegrade organic contaminants. All grasses grew and performed well.

THE CONCEPT FOR REHABILITATION OF PROBLEM SOIL DIKE USING MANUFACTURED SOILS

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Herbert Hoover Dike was established to protect south central Florida residents from flooding during hurricanes over the area. The dike system was constructed from dredging lake bottom from an interior canal and an outer rim canal. The dredged material consisted of sand and marl. The dike soil pH is approximately 8.3 in most areas. All maintenance vegetation work was accomplished through contracts.

Over the years the desired grass cover (Bahia, Bermuda, and/or St. Augustine grasses) have been replaced or out competed by weeds, such as *Napier* grass and/or *Maidencane*. Application of manufactured soil technology was accomplished in greenhouse screening tests and in a field demonstration. Productive manufactured soil was made and demonstrated using 60 percent in-situ dike soil and organic waste (sawdust, yardwaste, bagasse, or *Melaleuca* compost). Demonstration plots were established with four plant species: Bermuda grass, St. Augustine grass, Bahia grass, or perennial peanut.

Periodic evaluations have indicated that yard waste and N-Viro created a fertile soil and promoted an enormous growth of native weed seed. Weed control had to be implemented to allow the more desired species that were planted to survive. Use of bagasse as the organic waste source resulted in one of the best Bermuda grass coverage. Perennial peanut planting have been slow but are continuously expanding.

TECHNICAL SESSION 2: Wetlands A

Mary C. Landin, PhD, Chair

TWENTY-FIVE YEARS OF LONG-TERM MONITORING OF WETLAND PROJECTS CONSTRUCTED WITH DREDGED MATERIAL, WITH COMPARISONS TO NATURAL WETLANDS, THROUGHOUT U.S. WATERWAYS

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The US Army Corps of Engineers (Corps) Waterways Experiment Station (WES) has constructed a number of wetland and multiple habitat sites over the past 25 years. Over 1,000,000 acres of wetlands have been restored, created, protected, managed, and/or acquired under the Corps' various missions during that time. Prior to the early 1970's, the Corps "built" many wetlands incidentally to navigation and flood control projects, especially in the coastal zone, through the placement of dredged material adjacent to shorelines or during island creation when the Intracoastal Waterway System was constructed, while river, lake, and estuarine navigation channels were maintained, and when navigation channels were deepened and widened for various U. S. major rivers and ports. The Corps is also aware that it changed many wetlands during that same time period due to raising wetland elevations and construction of flood control levees, and similar civil works projects in an era when there was little understanding of the occurring or cumulative impacts.

During early Corps research programs, it constructed seven wetlands in the 1970's and four wetlands in the early 1980's using dredged material for purposes of detailed study and investigation as part of their goals. Broad research objectives for these projects included (1) restoration and/or creation of a functional wetland at a multiagency-chosen project location; (2) comparison of the wetland to similar nearby natural wetlands; (3) develop project plans, designs, contract specifications, and construction information that could be used as guides for similar wetland construction; (4) conduct both environmental and engineering short-term and long-term interdisciplinary evaluation and/or monitoring of these wetlands; (5) based on monitoring, determine the success or failure of these sites, as well as the lengths of time take to function as wetlands; (6) publish these findings in Corps and peer-reviewed literature, and use the information for technology transfer to aid the various Corps missions where wetlands restoration and creation is a factor (now including mitigation and mitigation banking). These sites are: (1) Gaillard Island, lower Mobile Bay, AL; (2) Pointe Mouillee, western Lake Erie, MI; (3) Lake of the Woods, Warroad, MN; (4) Southwest Pass, lower Mississippi River, LA; (5) Nott Island, Connecticut River, CT; (6) Windmill Point, James River, VA; (7) Buttermilk Sound, Altamaha River, GA; (8) Drake Wilson (Two-Mile) Island, Apalachicola Bay, Apalachicola, FL; (9) Bolivar Peninsula, Galveston Bay, TX; (10) Salt Pond #3, south San Francisco Bay, CA; and (11) Miller Sands Island, Columbia River, OR. They were compared to a total of 29 nearby, similar natural wetlands, and each one had from one to three natural wetlands monitored and compared. Although the dredged material wetlands were newly constructed, and are now between 14 and 25 years old, the natural wetlands' known ages ranged from 60 to 4,500 years old.

Since these eleven sites were built, the Corps under its navigation and flood control missions has restored and/or created a number of newer wetlands using dredged material as (as part or all of their substrates) or worked with 404(b)(1) permit applicants to design wetlands that do not yet have as long nor as extensive data sets (some examples are Jetty Island extension and Goglehite Wetland, Puget Sound, WA; several sites in the lower Columbia River, OR; Weaver Bottoms, MN; upper Snake River, Jackson Hole, WY; Kenilworth Marsh, Eastern Neck, and a number of other Chesapeake Bay, MD sites; Winyah Bay, SC; Aransas, West Bay, and numerous other sites in the Texas Intercoastal Waterway; several wetlands in the intertidal Delta and San Pablo Bay area of San Francisco Bay, CA; Riverlands, MO/IL; Lake George, MS; Tennessee-Tombigbee Waterway wetlands, TN/MS/AL---there are numerous others). Most of these sites are being monitored either as part of an agency structured monitoring plan or by volunteer efforts, and several will be the subject of other papers in this workshop. Important wetland restoration projects at Batiquitos Lagoon, CA, and the Houston Ship Channel, TX, that are being carefully monitored were constructed by the Ports of Los Angeles/Long Beach and the Port of Houston, respectively, using information obtained from Corps dredged material wetland research.

The information from the original eleven sites has been published in a series of 40 Corps technical reports, used in the writing of several Corps engineer manuals, two interagency engineer manuals published by the USDA Natural Resources Conservation Service, books and book chapters on wetland restoration and creation, and in numerous peer-reviewed journals and conferences. A more recent utilization of this extensive data set is its extrapolation and use by the Corps regulatory offices for dredge and fill-permitted wetland creation and restoration work. Created mitigation wetlands are still highly subject to failure due to improper location, design, and construction, and the Corps is striving to understand what can be done to make mitigation in practice more reliable and functional.

Engineering monitoring of the eleven sites included structure integrity, elevation changes, hydrology and hydraulics, erosion and/or configuration changes, and physical soil parameters. Environmental monitoring of the eleven sites included colonization and utilization by fish and wildlife species, including benthos and aquatic invertebrates; water quality; biological soil changes; vegetation colonization, survival, productivity, and stabilization; and general condition, health, and sustainability of the wetland. Initially, data were collected prior to construction, during construction, and post-construction (first three years) at intensive levels (monthly, seasonally). In out-years, data have been collected annually from year 4 through year 9, then every 3-5 years afterwards as funds were available. On the oldest wetlands monitored, data sets are 25 years old. Due to limitations of funding in out-years, not all parameters were measured at each sampling period, but observational data were collected instead. Where Corps contracts were in place, contractors collected data and provided reports and/or field data for analysis to the Corps. In the case of Gaillard Island, the State of Alabama took over monitoring in 1987, and have collected those data since that time.

Each of the eleven sites, with their comparison natural wetlands, has an individual set of results and some are very site-specific. Furthermore, the sites represent the diversity in geographic, soils, and climatic conditions under which the Corps must work routinely. Some are coastal and saline and some coastal and fresh intertidal; others are freshwater riverine or lacustrine. They ranged in size from 5 acres to 4600 acres. Summary results of overall wetland survival, growth, and sustainability for wetland restoration and creation, based on these and other Corps studies, are:

(1) Above-ground wetland vegetation biomass, wildlife, and fisheries compared very favorably with natural wetlands, and some were more heavily utilized than the natural reference sites. Exceptions included conditions where sandy substrates did not trap fines very fast (Bolivar Peninsula) or where erosion occurred due to poor location (Windmill Point). The Bolivar Peninsula site didn't match natural wetlands in macroinvertebrates for 15 years, but the Windmill Point did so immediately. Another exception occurred when the manmade site did not adequately develop its own tidal channels or creeks, and access for finfish and shellfish was not adequate (Salt Pond #3 and Bolivar Peninsula).

(2) Below-ground wetland vegetation and biological/chemical components of the substrate took as much as ten years to adequately match those of natural wetlands. Often, the above-ground biomass was abundant in early years, and was being supported by highly nutrient-enriched soils which required less below-ground biomass than older wetlands. Typical wetland soil profiles and chemistry took several years to develop, but once present, persist.

(3) New wetlands built with nutrient-enriched dredged material flourish initially, and even out over time to equal more typical wetland growth patterns. All of the sites exhibited these characteristics.

(4) Some of the studied sites required initial stabilization with temporary breakwaters until the substrates were vegetated and well established due to moderate wave energies and long wind fetches. One site, Pointe Mouillee, required a permanent breakwater due to wave and wind energy, ice, and need to contain contaminants, which has served very effectively. Another site, Windmill Point, had a dike failure, which caused the center of the wetland to wash out and become shallow water riverine habitat.

(5) Sites where careful attention was not paid to water energy, hydrology, and location (siting) within their landscapes resulted in partial failures due to subsidence, erosion or excessive trapping of sediment that changed the intended wetland from one type of a wetland to another type. One site, Bolivar Peninsula was originally to be low marsh, high marsh, and upland. Over time, the site subsided and it is now entirely low marsh. Another site, Southwest Pass, has such a dynamic subsidence rate that for each two acres constructed with dredged material, one acre will subside in about ten years. However, subsidence can be purposely addressed using dredged material. Lake

of the Woods eroded to a point of being completely submerged, but is supporting dense freshmarsh vegetation.

(6) All the sites reached a level of stability over time, and are changing less rapidly now. Although the wetlands appear visually to be stable and unchanging, subtle species changes are noted, and photographic records over time indicate some changes in configuration, elevation, and communities still occurring.

(7) Sites are still providing significant habitats for wildlife and fish abundance and diversity. Each of the eleven sites are supporting one and usually more rare, threatened, and endangered species which utilize the wetlands for all or part of their life requirements. One site, Miller Sands Island, has been listed as critical habitat for salmonid species in the Columbia River.

(8) Substrate (dredged material) stabilization was critical in moderate wave energy conditions, and edge erosion creep is evident where this is the case. Sites evidencing this problem are Salt Pond #3 and Apalachicola Bay.

(9) Statistical analyses of planted wetland vegetation, propagation, fertilization, germination, survival, and reproduction were made at eight sites to help determine what species worked best, and under what conditions. It was determined that under most conditions, vegetative propagules worked better than seeds, no fertilizer was necessary for long-term plant cover, and denser plantings (0.5 m centers vs. 1.0 m centers) did not matter over time. Coastal sites required planting, while freshwater sites most often could colonize naturally. Natural colonization was also documented, and Point Mouillee, Windmill Point, and Lake of the Woods were naturally colonized rather than planted.

(10) Larger wetlands, whether manmade or natural, tended to be more diverse, and provided for more fish and wildlife use than smaller wetlands, as well as met other wetland functions. Examples of larger sites were Miller Sands Island, Gaillard Island, and Pointe Mouillee, all of which provided significantly more habitat of all types and met other functions than did the smaller wetlands. Extrapolated, larger dredged material, or dredge and fill, wetlands tend to function better than smaller wetlands (although there is still a place for some pocket wetlands within landscapes). This is one of the reasons that the Corps is now more willing to consider use of larger mitigation banks rather than small, piecemeal mitigation projects that are often doomed to failure from conception.

There are many other results from these studies, and all the information gained can be used to build future wetlands or make restorations and repairs to degraded wetlands. If correctly planned, placed, designed, and implemented, with follow-up monitoring and on-site corrections if necessary, wetland restoration and creation using dredged material (dredge and fill) is feasible, predictable, economically efficient, and successful. Realistic goals and objectives, economics, and management plans are critical to make a wetland project work.

No wetland, manmade or natural, will meet all recognized functions of wetlands because not all functions are applicable to each wetland type, and no manmade wetland should be designed to attempt this. There are many reasons for restoring and creating wetlands, and mitigation for dredge and fill, and wetland restoration and creation using dredged material from navigation or flood control projects, are just two of them. Twenty-five years of data proving that dredged material wetlands can be built is a track record of which the Corps is very proud.

HABITAT RESTORATION USING DREDGED MATERIAL: THE SONOMA BAYLANDS WETLAND DEMONSTRATION PROJECT

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The Sonoma Baylands Wetland Demonstration Project is restoring tidal salt marsh on 289 acres of diked land using 1.9 million cubic yards of dredged material. The project site is located on the northern shoreline of San Francisco Bay in Sonoma County, California. Construction of the wetland restoration project was authorized by Congress in 1992. The San Francisco District, Corps of Engineers is currently completing construction of the project.

Initial planning for the Sonoma Baylands project was conducted by the California State Coastal Conservancy and the Sonoma Land Trust. The design of the project incorporates lessons learned through the review of past tidal wetland restoration projects in San Francisco Bay. Rather than attempting to construct an "instant marsh," the project is designed to allow a tidal salt marsh system to naturally develop over a relatively short period of time while minimizing construction costs. Dredged material is being used to accelerate the re-establishment of intertidal marsh elevations on the former tidal wetlands, which had subsided about six feet. The final surface of the restored marsh, including the tidal channel system, will be created by the natural deposition of suspended sediment on top of the dredged material following the restoration of tidal action.

Construction of the Sonoma Baylands project began in June 1994. Approximately 207,000 cubic yards of maintenance-dredged material from the Petaluma River navigation channel were hydraulically placed in a 29-acre pilot unit in Fall 1994. The following year, approximately 1.7 million cubic yards of suitable dredged material from the Oakland Harbor deepening project were placed in the 260-acre main unit by hydraulic pipeline from a temporary barge pump-out site. The pilot and main units were reopened to tidal action by breaching the former bayfront levee in January and October 1996, respectively. The total construction costs, including lands and design costs, are projected to be $7.6 million. These costs include the additional cost of transporting Oakland Harbor dredged material to the restoration site in lieu of ocean disposal.

Other significant project features included the construction of 11,700 linear feet of new levee along the landward periphery of the restoration site to allow the site to be opened to unrestricted tidal action. A series of earth berms was constructed within the restoration site to act as wind-wave barriers, direct channel formation away from the peripheral levee, and facilitate the hydraulic placement of dredged material within the site. Twenty-one electrical resistivity staffs were installed within the pilot and main units to allow remote monitoring of the placement and subsequent consolidation of the dredged material. This was the first known use of electrical resistivity techniques to monitor the hydraulic placement of dredged material.

In addition to describing the history, design and construction of the Sonoma Baylands project, the presentation of this paper will also include the most current results of initial post-construction monitoring of the physical and biological development of the restored wetland.

BENEFICIAL USE OF DREDGED MATERIAL FROM THE DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT TO CREATE/RESTORE/PROTECT WETLANDS IN THE DELAWARE BAY

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Based on the findings of the February, 1992 Delaware River Comprehensive Navigation Study Main Channel Deepening Interim Feasibility Report and Environmental Impact Statement, the Preconstruction Engineering and Design (PED) Study efforts were initiated in March, 1992. The feasibility study recommended modification of the existing Federal Navigation channel from 40 feet at mean low water to 45 feet. The proposed project provides for a full width channel that would follow the existing channel alignment from the Delaware Bay to the Philadelphia/Camden waterfront, a distance of about 102.5 miles.

The proposed project includes all appropriate bend widening as well as provision of a two space anchorage at Marcus Hook. Approximately 33 million cubic yards of dredged material would be removed for initial construction over a four year period. Dredged material from the river would be placed in additional confined upland disposal areas. Material excavated from the Delaware Bay would be primarily sand and would be used for beneficial purposes including wetland environmental restoration and underwater sand stockpiling. The proposed channel deepening project was authorized in October 1992 as part of the Water Resources Development Act of 1992.

A critical component of this feasibility study is the design of the beneficial use projects including Kelly Island, Delaware, and Egg Island Point, New Jersey wetland restoration sites to benefit target species. These wetland areas are presently experiencing erosion of from 15 to 30 ft per year. The Kelly Island site will consist of a 60 acre intertidal *Spartina alterniflora* marsh made from a mixture of sand and silt substrate, enclosed by a + 10 ft MLW crest elevation sand dike, approximately 5000 ft long, and from 200 to 350 ft wide, with a sand filled geotextile tube core. It will have a water control structure for post-construction water level management and tidal flushing that allows for the exchange of aquatic organisms. The sand dike will provide spawning habitat for horseshoe crabs (*Limulus polyphemus)*, as well as nesting and feeding areas for waterbirds.

The southeastern side of the existing marsh at Egg Island Point will be protected by a single geotextile tube structure, with a crest elevation of +5 ft MLW, placed on top of a dredged material sand foundation built to elevation 0 feet MLW. The 135 acre area within the lee of the structure will be filled with sandy dredged material to an elevation of + 5 feet MLW, and extend for approximately 1.7 miles along the shoreline. These elevations will be inundated daily during high tide periods. A combination of intertidal marsh and shallow open water habitat is expected to develop behind the tube. The sand placed in the lee of the breakwater should provide abundant horseshoe crab spawning habitat, unless it becomes vegetated. Waterbirds, shorebirds, and juvenile fish will use the low marsh and tidal pools and, any washback of sand into the high marsh zone would provide both additional horseshoe crab spawning areas, and potential tern, gull, and other waterbird nesting areas.

A staggered alignment of single geotextile tubes, 200 ft long, with a crest elevation of +5 ft MLW, with one set of tubes close to the shoreline, and a second set of tubes about 50 feet offshore will be placed along two miles of the northwestern shoreline of Egg Island Point. This area will have no fill material placed behind the tubes, and is designed to reduce the erosion rate of the existing marsh without blocking tidal flow or access by aquatic organisms.

DESIGN OF SAND DIKE FOR WETLANDS AND BEACH RESTORATION AT KELLY ISLAND, DELAWARE

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As part of the Delaware River channel deepening project, Kelly Island, DE is designated a beneficial use site for dredged material placement. The primary project objective is to provide one mile of shoreline protection for the southern end of Kelly Island. The project must use 200,000 cubic yards of silts and at least one million cubic yards of sands removed from the channel. The final project design will consist of 60 acres of restored wetlands with a sandy beach for horseshoe crab, shorebird, and waterbird habitat. Additionally, the project will provide partial protection of the Mahon River entrance.

The sand containment dike must successfully protect the 60-acre wetland for a minimum of 10 years. The wetlands configuration requires a 5,000-ft long containment dike along the -6-ft, MLW, contour. To minimize overtopping which might adversely affect the wetlands, the dike crest elevation will be +10 feet, MLW, representing a 10- to 25-year return water level. In evaluating the optimum design volume for the sand dike, losses in crest width resulting from storm damage and daily longshore transport were evaluated separately.

Storm crest-width losses were evaluated two-dimensionally by employing SBEACH, a numerical model which simulates cross-shore beach- and nearshore-profile response to storm events (Rosati et al., 1993). Using wave parameters representing storm events corresponding to 2- through 25-year return events provided by Ocean and Coastal Technology, Inc. (OCTI), several SBEACH simulations were made. First, initial equilibrium profile adjustment was estimated using the 2-year event and assuming a 1:20 initial side slope. This SBEACH simulation indicates a crest-width reduction of 20 feet and a slope change to 1:40. SBEACH simulations using an initial cross-section which reflects the 1:40 equilibrium slope were run for the various return events. Only the 25-year event simulation showed significant crest-width losses, i.e. 30 feet. This return event is represented by a wave height and period of 8.2 feet and 13.4 s.

Net northerly longshore transport rates predicted by OCTI ranged from 25,000 to 50,000 cu y per year. Assuming sand is removed from the berm's offshore slope in a layer of uniform thickness, the crest width will recede 13.5 ft per year, on average. Summing the computed recession values due to longshore transport over 10 years, the initial equilibrium adjustments, and losses due to a 25-year event results in a minimum crest width of 185 feet. Rounding up to a 200-ft crest width corresponds to a total dike volume equal to 1.7 million cubic yards.

Rosati, J.D., Wise, R.A., Kraus, N.C., and Larson, M., 1993. "SBEACH: Numerical Model for Simulating Storm-Induced Beach Change, Report 3, User's Manual," IR CERC-93-2, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

TECHNICAL SESSION 3: Hart-Miller Island Panel

Wayne Young, Chair

HART-MILLER ISLAND: FROM REMNANT ISLANDS THROUGH CONTAINMENT FACILITY TO PARK AND NATURAL RESOURCES AREA

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Construction of the 1100-acre Hart-Miller Island Dredged Material Containment Facility (Hart-Miller) was motivated by a statutory and practical need to contain contaminated dredged material from the Patapsco River and to provide placement capacity for channel maintenance and improvement needed to maintain the Port of Baltimore's competitiveness for maritime commerce. The facility was specially constructed and is operated to provide for environmentally sound and safe containment of contaminated sediments. Although not initially billed as a "beneficial use" project, Hart-Miller continues to be developed and used as a multi-purpose site which provides substantial environmental, social, and economic benefits. Under an arrangement between the Maryland Port Administration (MPA), which sponsored construction, and the Maryland Department of Natural Resources (MDNR), which holds title to the property for the State of Maryland, the entire complex will be completely converted into a recreational and natural resource area once deposition of dredged material is concluded. The containment facility was vigorously opposed through litigation that culminated in a US Supreme Court decision which enabled project implementation.

Perimeter dike construction to +18 feet mean low water (MLW) began in 1981 and was completed in 1984. The dike system reunited and protected the fast eroding remnants of Hart and Miller Islands at the mouth of Back River and established a recreational beach between them. The facility has provided shelter for the constructed beach, preserved shallow water habitat surrounding the remnant islands as well as containment island habitat, and provided physical protection for the shorelands to the west from wind-generated waves, winter storms, and the movement of large ice floes. The MDNR established a park facility that today consists of a park ranger station, recreational beach, self-composing toilet systems, boardwalk, observation tower, primitive camp sites, and nature trails. A second-tier dike system to elevation +28 feet MLW was completed in 1989 with an accompanying commitment not to raise the dikes again. This was necessitated when opposition to ope-water placement of dredged material precluded use of this traditional placement alternative.

The containment cells have been operated by the Maryland Environmental Service (MES) for the MPA since 1984. These activities and advice on habitat park development have been reviewed by the State-chartered Hart-Miller Island Citizens Oversight Committee. Discharges from the facility are performed under a state discharge permit administered by the Maryland Department of the Environment, which also conducts a rigorous environmental monitoring program to safeguard Chesapeake Bay's aquatic environment. While active, the containment cells have served as valuable "interim" wildlife refuges for waterfowl, with freshly placed dredged material providing benthic organisms as food sources. MES, under MPA sponsorship, has in recent years conducted an aggressive crust management program to optimize consolidation of dredged material insofar as practical, thereby increasing facility capacity and useful life while concurrently allowing more time to continue the search for suitable alternative placement options. MES experimented with and refined crust management techniques in coordination with the MPA which have proven to be very effective for a large-scale confined disposal facility. Deposition in the South Cell was completed in 1990, after which MES conducted crust management to further consolidate the materials. A concept plan for conversion of the South Cell to wildlife habitat and perched wetlands for wildlife utilization, combined with upland/island forest, was developed by the US Army Engineer Waterways Experiment Station Environmental Laboratory (M. C. Landin) for the MDNR, MPA, and MES in 1993-1994.

Although a very substantial effort was made for over a decade to find and secure alternative placement sites, participants in the multidisciplinary, inter-organizational Dredged Needs and Placement Options Program sponsored by the MPA and facilitated by MES concluded in August 1994 that it was necessary to reconsider increasing the height of the Hart-Miller dikes so that safe navigation in existing channels could be maintained in the near term. After extensive institutional and public coordination and involvement, the State decided to expedite conversion of the South Cell for passive recreation and wildlife habitat, and to raise the North Cell dike system to +44 feet MLW. Modifications to the State wetlands license and discharge permit and the federal Clean Water Act 404 permit were obtained. The Maryland Department of Transportation also committed to establishing a visual screen of native upland/island-adapted tree species on the back slope of the recreational beach (called for in the WES Concept Plan). A phased, $13.4 million, 4-year construction program was developed by the MPA, MES, and the engineering design consultant, Gahagan and Bryant Associates, and begun in mid-1996. MES managed design construction for the MPA. On-site borrow material was excavated from the South Cell using bulldozers and a dragline, transported to the North Cell via off-road dump trucks and placed onto the back slope of the second tier dike. New spillways were constructed. Close coordination by the full construction team consisting of the MPA, MES, engineering design and geotechnical consultants, and dike and spillway sub-contractors overcame significant uncertainties associated with the South Cell borrow areas and other site-specific conditions. The results of this coordination and the use of the rental arrangement for construction equipment and operators rather than a construction contract enabled accelerated construction. Raising the perimeter dike to +44 feet MLW was completed in May 1997 at 50 percent of the cost and three years ahead of schedule.

MES, on behalf of the MPA, arranged for the planting of 200 4-inch-diameter trees in three stands on the western perimeter dike. The planting began in Fall 1996 and was completed in April 1997. Also on behalf of the MPA, MES contracted for the Alliance for the Chesapeake Bay to supply volunteers to plant 6000 smaller trees and cuttings during March-April 1997. MES also donated 20,000 cubic yards of compost made from yard waste which was transported to Hart-Miller under oversight of the MPA and stockpiled in the South Cell for use in the tree buffer plantings and in converting the South Cell into wildlife/wetlands habitat. The Baltimore Corps District, in coordination with the MDNR, MPA, and MES, is conducting a Section 1135 project for the South Cell habitat conversion. The Maryland General Assembly subsequently codified specific termination criteria for conclusion of dredged material deposition and conversion of both cells for recreation and habitat. Meanwhile, the dredged material placement cycle and essential maintenance of harbor and approach channels were continued without interruption.

The seven panelists from MPA and MES will discuss Hart-Miller Island conception, baseline, planning, design, construction, monitoring, and management aspects of the 16-year-old island and solicit questions and comments on their project from workshop participants.

TECHNICAL SESSION 4: Economics and Challenges of Beneficial Uses of Dredged Material

Carol A. Coch, Chair

THE ECONOMICS OF UPLAND DREDGED MATERIAL MANAGEMENT AND BENEFICIAL USE: A CASE STUDY IN SAN LEANDRO, CALIFORNIA

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The City of San Leandro, in the San Francisco Bay Area, has recently implemented a comprehensive management plan for its existing 100-acre onshore dredged material disposal site. The City has, for more than twenty years, used the site for upland disposal of dredged sediments generated during periodic maintenance dredging episodes at the City's nearby marina. This site is the only operating upland dredged material disposal site in the Central and South Bay regions.

As part of a mitigation package developed to satisfy regulatory requirements, the City recently developed a management plan to enable a greater range of beneficial uses for its dredged material. In particular, the plan had the overall purpose of enhancing the value of the Dredged Material Management Site (DMMS) as seasonal shorebird and other water bird habitat in ways that were compatible with its primary function of dredged material drying and temporary storage.

At an initial cost of over $2 million, the City reconfigured the site by constructing new levees and removing previously deposited dredged material to achieve suitable elevations for habitat enhancement. In addition, islands were constructed within the site to increase shoreline edge and to provide resting habitat for water birds, while weirs and culverts were installed to enable appropriate water circulation. With these improvements, the site can be flooded seasonally with tidal water from San Francisco Bay to provide an invertebrate food supply for shorebirds. Introduction of the tidal water was made possible by completion of a separate but related City project to enhance approximately 172 acres of adjacent diked wetlands at a cost in excess of $1 million.

The DMMS began its first full season of operation in the Fall of 1996. Monitoring of the site has thus far indicated increased use by migratory and resident waterfowl and shorebirds.

While implementation of the City's DMMS management plan will likely demonstrate that dredged material management and habitat management can beneficially coexist, the City faces considerable economic pressures as it copes with the high cost of disposing of its dredged material in this manner. Dried dredged material removed from the site has thus far been used beneficially as cover material for nearby sanitary landfills and also in the adjacent San Leandro Shoreline Marshlands wetland restoration project. However, the requirement to "double handle" the material and truck it off-site has resulted in significant expenditures on the City's part. The net unit cost to dredge and dispose of dredged material using the upland DMMS has been as high as $18.00 per cubic yard, more than twice the estimated cost for in-Bay aquatic disposal.

The emerging Long Term Management Strategy for the placement of dredged material in the San Francisco Bay Region emphasizes increased upland disposal coupled with wetland habitat creation and/or restoration. Action alternatives currently under consideration would promote a region-wide doubling to a quadrupling of dredged material managed in this way. While the San Leandro experience appears likely to demonstrate that this approach is environmentally desirable, there remain serious questions with regard to the financial feasibility of this approach, particularly for the smaller ports and harbors of the Bay Area.

THE CVN HOMEPORTING PROJECT IN SAN DIEGO BAY: A SERIES OF CHALLENGING ISSUES SURROUNDING THE BENEFICIAL REUSE OF NINE MILLION CUBIC YARDS OF SEDIMENT

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The Base Realignment and Closure (BRAC) Commission directed that the CVN aircraft carrier assets of Naval Air Station (NAS) Alameda, California, be reassigned to NAS North Island in San Diego Bay, California and to Puget Sound, Washington. Berthing a CVN in San Diego Bay requires a considerable amount of new facilities construction and dredging. To ensure the safe and routine navigation of a CVN, the turning basin adjacent to the existing carrier wharf and the San Diego Bay Navigation Channel must be deepened to -50 ft MLLW. This project will ultimately yield over 9 million cubic yards of sediment. Construction is scheduled to be completed in 1999 in time for the arrival of the USS John Stennis, CVN-74.

Chemical and biological testing of the proposed dredged material indicated that the majority of the sediment was sandy and free of chemical contamination, consequently, 7 million cubic yards of material were permitted for beach replenishment. A smaller portion of the sediment, approximately 2 million cubic yards, was determined to be suitable for placement at the designated open ocean disposal site located 5 miles offshore of San Diego. This material was clean, but not sandy enough for beach placement.

Approximately 100,000 cubic yards of sediment was deemed unsuitable for open ocean placement due to chemical contamination that resulted in significant toxicity in laboratory bioassay analyses.

The greatest beneficiaries of the CVN Homeporting Project will be badly eroded San Diego County beaches ranging from Oceanside to the Mexican border. The Navy and the San Diego Association of Governments (SANDAG) identified potential receiver beaches base on their need and the potential impacts of the disposal operation on sensitive resources (e.g., surfgrasses and reefs).

A secondary benefit of this project is the construction of a 13-acre fill site which will serve as a new carrier wharf. This wharf is situated on top of an Installation Restoration (IR) site which is located in the nearshore area adjacent to the existing aircraft berthing wharf. Development of this fill area will effectively eliminate contact by bay water and sensitive receptors from the IR site sediments.

To mitigate for filling 13 acres of bay bottom, the Navy has designated a 16-acre site at NAS North Island to be excavated back to bay level. This area will be planted with eelgrass, and rock structures will be deployed to serve as fish habitat. Soil excavated from this area, which is historic fill from bay dredging, is being used as habitat enhancement for nearby least tern and snowy plover nesting sites.

A CASE FOR EXPANDING TRADITIONAL USES OF DREDGED MATERIAL

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Beneficial re-use of dredged material from navigation and flood control projects are essential to the sediment budget of West Coast littoral cells. Littoral cell sediment budget issues are merely a sub-set of larger issues associated with watershed management. Unfortunately, upland policies of watershed management, especially flood control and water storage, have driven management decisions and strategy with little regard for downstream issues related to beach erosion and littoral cell sediment deprivation.

In coastal southern California alone, flood control and water resource structures possess sediment impoundment capacities in excess of three billion cubic yards. Additionally, impoundments occur from management decisions related to navigational and commerce purposes on navigable waters. These management decisions have profoundly impacted the coastal environment, changing the shape and nature of the shoreline and altering the biological resources and beneficial uses.

In recent years, local governments, prompted by growing public concern, have sought low cost sources of sediments for beach replenishment including: terrestrial borrow sources, dredged material, and offshore borrow sources. Efforts to utilize these sources have often been stymied because they fall outside the narrow criteria of what is considered "beach compatible" by federal regulatory and resource offices (EPA, Corps, NOAA National Marine Fisheries Service, US Fish and Wildlife Service). Regulatory concerns often focus on excessive fine-grained sediments in potential re-use material, as this fraction is believed to produce significant impacts of biota through burial, turbidity, contaminant exposure, and impacts of exposed hard-bottom habitat. These concerns are often misdirected, as nearshore biota are naturally adapted to large seasonal movement of sediments and changing sediment depths.

Nearshore infauna avoid or recover rapidly from moderate burial and turbidity, as many are effective burrowers and/or highly mobile. Large organisms like sand dollars tolerate some burial, but often move offshore in winter, affording opportunities for beach replenishment with minimal impact. Eel grass habitats are not plentiful on the open coast, but where these areas occur, beach replenishment should be limited or mitigated by replanting upon project completion. Similarly, nearshore biota including algae are adapted to seasonal changes in turbidity associated with storms, seasonal movement of littoral sediments, and run-off from precipitation. Thus, disposal of fine sediments onto beaches can be managed to reflect natural cycles to reduce replenishment impacts. Furthermore, some biota (e.g., amphipods and cumaceans) are actually attracted to turbidity plumes associated with beach replenishment using dredged material.

The fear that fine-grained sediments deposited on the beach will move and bury exposed hard-bottom habitats has some validity. However, for many areas of the California coastline these exposed hard-bottom habitats are an unnatural condition resulting from mis-management of the watershed. Public sentiment seems to be favoring beaches over cobbles and intertidal rocky habitats.

Finally, it is important to understand that fine-grained sediments in the nearshore environment is part of the natural watershed and littoral cell cycle. On uncontrolled rivers, sediment content during high volume flows typically consists of 85-95 percent suspended loads of clay and silt. These fine-grained sediments are distributed throughout the nearshore environment and then reworked by wave resuspension and littoral transport to areas of deposition. The deposition of fine-grained sediments upon our beaches is not a long-term solution, but it helps supplement littoral sediment losses with few adverse impacts and provides many beneficial uses and the maintenance of vanishing habitats. Critical to the discussion in our presentation is the question: is current regulatory guidance maintaining much higher standards for turbidity and sediments than that occurring naturally?

AN ESTIMATION OF AVERAGE COSTS AND PERCENTAGES OF BENEFICIAL USES FROM THE MAINTENANCE OF FEDERAL NAVIGATION CHANNELS BY U.S. ARMY CORPS OF ENGINEERS DISTRICT

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The volume of material produced by the New Orleans District, U.S. Army Corps of Engineers' (MVN) maintenance dredging projects for Federally-maintained navigation channels are among the greatest volume projects of any Corps dredging projects in the U.S. Because of this, fixed costs as a percentage of total project costs are low. The average cost of the typical MVN dredging project is therefore among the lowest of all such projects in the nation.

The Louisiana Department of Natural Resources (LDNR), Coastal Management Division, has a strong interest in the beneficial use of Louisiana dredged material. Louisiana's coastal zone suffers from a combination of sediment starvation, subsidence, and erosion which are causing the loss of an average of 29 square miles of important coastal wetlands per year. Fortunately, there are numerous shallow open water areas in close proximity to many of Louisiana's Federally-maintained navigable waterways that are favorable for the beneficial use placement of dredged material resource for wetland restoration or enhancement.

Because of LMDR interest, research efforts were undertaken to compare the average costs of dredged material disposal for the MVN to those of other Corps Districts. Pre-dredge estimates of total cubic yardage of material and total project cost were obtained for the years 1990 to 1995 from the Corps Navigation Data Center, Dredging Statistics Program. For each Corps District in the United States that reported dredging information to the Navigation Data

Center, total pre-dredged estimates of quantities of dredged material to be disposed and the total dollar amounts of the winning contract bid for a maintenance event were summed in a Lotus spreadsheet. Average costs per Corps District were computed as the sum of winning contract bids divided by the sum of estimated cubic yards of dredged material per fiscal year. Tables presented summarizes the results for fiscal year 1995.

An additional research need which was identified was the amounts and total percentages of dredged material disposal used beneficially. For the purposes of this study beneficial use was defined as any environmental enhancement project, land creation for development, or any project that has positive benefits to society. A data field titled "disposal type" in the Dredging Statistics Program data base contains codes for dredged material disposal procedure used. Two of the codes within this data field, "beach nourishment" and "wetlands nourishment or creation", are clearly and easily quantified as an environmental enrichment beneficial use. However, the remainder of the data codes are ambiguous as to whether the disposal type can be considered a beneficial use. For example, the disposal type codes "confined", "mixed", and 'upland", all have the potential to be beneficial uses and to have positive environmental enrichment consequence or other benefit to society but the final fate of projects coded in that manner could not be determined. Refinement of the data input and coding is necessary to accurately reflect the actual amounts of dredged material beneficially used each year by the Corps.

For this presentation, the total estimated quantity of dredged material associated with the two unambiguous beneficial use data codes were summed by Corps district for 1995. In addition, the disposal code for "beach nourishment and upland disposal" was arbitrarily halved and summed with the two unambiguous disposal codes to obtain an rough estimate of percentage of dredged material used beneficially by Corps district in that fiscal year.

A telephone survey of dredging professionals employed in Corps districts across the United States was conducted to obtain an ad-hoc estimate of percentage of beneficial uses to compare with the estimate generated from the Dredging Statistics Program data. For Corps districts that could not be contacted, an ad-hoc percentage of district beneficial use of dredged material estimate was provided from Waterways Experiment Station (WES) project files on District work conducted and/or coordinated by WES. In addition, for the MVN, estimates of disposal activities were obtained from the MVN annual Dredging Conference information package for FY 95 and in Consistency Determinations submitted to the LDNR Coastal Management Division for specific dredging projects. The estimate generated by the more detailed information is also compared to the two previous estimates.

Based on the information received through the telephone survey and on the estimates generated with the detailed MVN dredging information, we estimate that 40 percent of all the material dredged by the Corps is used beneficially in some way. We also conclude that the current Dredging Statistics Program data field, "disposal type" is insufficient to compute accurate estimates of material used beneficially in the U.S. In most cases the Dredging Statistics Program data base probably underestimates Corps district beneficial use of dredged material. It would be helpful if protocols were developed by which more accurate beneficial use estimates may easily be generated. We feel that this information would be very useful to the Corps as well as states where navigation and flood control dredging occurs and to the dredging industry.

CORPS DIVISION/DISTRICT (does not reflect 1997 Division name changes within the Corps)	Average Costs to Dredge One Cubic Yard of Material	Percentage of Material Used Beneficially Based on Telephone Survey	Percentage of Material Used Beneficially Based on Dredging Statistics Program Data
LOWER MISSISSIPPI RIVER DIVISION			
VICKSBURG	$1.23	0 %	0 %
MEMPHIS	$0.84	0 %	0 %
NEW ORLEANS	$0.81	25 %	18 %
SAINT LOUIS	$1.26	< 10 %	0 %
NORTH ATLANTIC DIVISION			
BALTIMORE	$4.60	80 - 90 %	10 %
NEW YORK	$7.43	NO INFORMATION	92 %
NORFOLK	$3.47	20 %	9 %
PHILADELPHIA	$2.69	20 %	0 %
NORTH CENTRAL DIVISION			
BUFFALO	$3.65	< 5 %	0 %
CHICAGO	$3.58	<5 %	0 %
DETROIT	$6.42	40 %	30 %
ROCK ISLAND	$2.77 *	< 5 %	0 % *
SAINT PAUL	$5.59*	100 %	0 % *
NEW ENGLAND DIVISION (NO DISTRICTS)			
DIVISION TOTAL	$8.10	< 5 %	9 %
NORTH PACIFIC DIVISION			
ALASKA	$8.17	<10 %	12 %
PORTLAND	$1.72	90 %	< 1 %
SEATTLE	$3.77	90 %	3 %

MISSOURI RIVER DIVISION			
NO INFORMATION AVAILABLE			
PACIFIC DIVISION			
HONOLULU	NO INFO	0 %	NO INFO
OHIO RIVER DIVISION			
HUNTINGTON	$3.88	<5 %	0 %
LOUISVILLE	$4.33	0 %	0 %
PITTSBURGH	$8.58	0 %	0 %
SOUTH ATLANTIC DIVISION			
CHARLESTON	$1.60	40 %	0 %
JACKSONVILLE	$6.91	25 %	95 %
MOBILE	$1.91	20 %	2 %
SAVANNAH	$2.10	30 %	0 %
WILMINGTON	$2.83	100 %	48 %
SOUTH PACIFIC DIVISION			
SACRAMENTO	$11.59	30 - 40 %	0 %
LOS ANGELES	$8.28	20 %	32 %
SAN FRANCISCO	$1.94	25 %	0 %
SOUTHWESTERN DIVISION			
GALVESTON	$0.77	10 %	0 %
LITTLE ROCK	$0.92	0 %	0 %

* Based on 1993 Data, 1995 Data unavailable

TECHNICAL SESSION 5: Manufactured Soil B

Charles R. Lee, PhD, Chair

MANUFACTURED SOIL FROM MOBILE HARBOR DREDGED MATERIAL

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Manufactured soil was tested using dredged material from confined disposal facilities adjacent to Mobile Harbor together with International Paper cellulose mud or sawdust and reconditioned sewage sludge (N-Viro^{R}). Greenhouse screening tests indicated that plant growth in blends of dredged material and IPC cellulose mud were not as good as expected. While ryegrass grew, tomato, marigold, and vinca did not. Excess sodium in the industrial paper waste cellulose mud may have been a contributing factor. Sawdust improved growth, however, better growth was observed with 40 percent or less dredged material. Additional evaluations will be required to determine the reasons for the unexpected poor growth.

FEASIBILITY OF MANUFACTURING SOIL FROM TEXAS GULF INTRACOASTAL WATERWAY DREDGED MATERIAL

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Each year nearly 10 million cubic yards of sediment are dredged from the Texas Gulf Intracoastal Waterway (GIWW). Since many of the current disposal sites have become filled and more are being filled, alternatives to confined disposal facilities (CDF) are being considered. The Texas Department of Transportation in conjunction with the Center for Dredging Studies at Texas A&M University is investigating alternatives for the disposal of dredged material resulting from the long-term maintenance of the Texas GIWW. One of the proposed alternatives is to use dredged material in combination with other bio-solids to produce an artificial, or manufactured,

soil. The purpose of this paper is to discuss the applicability of manufactured soil as a beneficial use of dredged material and its feasibility for Texas.

Manufactured soil is created using dredged material and recyclable organic waste materials such as bio-solids (sewage sludge), animal manure, yard waste, and bio-mass (cellulose or saw dust). Manufactured soil helps reduce and recycle wastewater sludge and provides an alternative for the long-term management of dredged material disposal sites by reducing the area needed for the placement of dredged material in a confined disposal facility (CDF).

A limited number of studies and test sites have been used to demonstrate the ability of combining dredged material with sewage sludge to create a manufactured soil. Research by the Waterways Experiment Station in conjunction with local Corps of Engineers Districts has produced favorable results in the area of manufactured soil. By using these results, it is hoped that this technology may be applicable to the dredged material from the Texas GIWW.

There are several factors that need to be considered for this technology to be feasible in Texas. The site selection in terms of location, material, and marketing are paramount in determining the most economically feasible alternative. Location in terms of dredged material, sewage treatment facility, and potential markets all must be considered. The chemical composition of the dredged material must be addressed since the material from the Texas GIWW will have a significant salt content. The amount of salt will have an affect on the application of the manufactured soil. There are several salt resistant plants and grasses, and they should be considered as the intended cover that will grow in the manufactured soil.

There are many locations along the Texas coast suitable for this technology. Several areas have been reviewed, and a selection of two potential testing sites has been determined. The sites are Matagorda Bay near the mouth of the Colorado River and Port Bolivar on the Galveston Bay side of Bolivar Peninsula. The economic factors that control the final selection for the test site will be presented. In addition, the equipment required for the manufacturing the new soil product will be discussed.

MANUFACTURED SOIL FROM ST. LUCIE MUCK

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Muck removal from St. Lucie Estuary has been suggested as a way of restoring the estuary to a more productive ecosystem. The potential beneficial use of the muck as an ingredient to manufactured soil products and as an amendment to depleted, droughty sandy soil on the Herbert Hoover dike system surrounding Lake Okeechobee was studied in greenhouse screening tests.

Test results indicate that St. Lucie muck could be used as an amendment to Herbert Hoover soil at a rate up to 10 percent of the blend. Up to 50 percent St. Lucie muck could be used for manufactured soil that would be suitable for grass growth, provided the muck was rinsed to reduce the salinity or other growth suppressing factors. Additional reconditioning will be required for growth of tomatoes, marigold and vinca.

MANUFACTURED SOIL CONCEPT IN THE REHABILITATION OF HOUSING DEMOLITION SOIL AND MILITARY TRAINING LAND

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The manufactured soil concept was applied to barren, infertile housing demolition soil and depleted, sandy soil in military training land at Ft. Drum. Old housing areas were demolished after new housing was developed on the installation. After demolition, infertile soil containing glass, pieces of roof shingles, wood fragments, nails and anything left over from the demolition was sparsely vegetated and an eyesore. In addition, intensive training with armored vehicles resulted in sparsely vegetated, highly wind and rainfall erodible training soil on many areas.

Greenhouse screening tests were conducted on both types of soils using organic waste materials and biosolids. Sawdust was blended with each soil along with either reconditioned sewage sludge biosolids (N-Viro^R) or reconditioned dairy cow manure (BionSoil^R). Ryegrass, tomato, marigold and vinca were grown in various blends to determine the most fertile mixture. The test results indicate that improved plant growth can be obtained through the appropriate blend of ingredients. The next stage of this technology development is a proposed field demonstration.

TECHNICAL SESSION 6: Wetlands B

Mary C. Landin, PhD, Chair

RIVER CORRIDORS AND WETLANDS RESTORATION AND THE POSSIBILITIES FOR THE BENEFICIAL USE OF DREDGED MATERIAL

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Recent efforts by the Environmental Protection Agency to initiate and support community-based restoration of river corridors should incorporate the use of dredged material where river sediments once sustained floodplain wetlands systems. While much of the historic focus of aquatic environmental statutes and regulations has been on contaminant controls and attaining chemical standards of cleanliness, river and stream health is significantly measured in physical and biological terms as well. Returning wetlands and floodplain habitat to modified river corridors is integral to addressing true watershed health, in both form and function. More commonly used in coastal and island creation projects, dredged material can also be applied to reinvigorate river floodplains that have long been denied sediment by levees and other water control measures.

The objectives of river corridors and wetlands restoration will be presented, including considerations of science, economics, and community participation. Opportunities and examples of dredged material use in restoration will be discussed.

MISSISSIPPI RIVER OUTLETS, VICINITY VENICE, LA: WETLAND DEVELOPMENT AND BIRD ISLAND DEVELOPMENT AT BAPTISTE COLLETTE

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In 1977, the Corps of Engineers enlarged the existing Baptiste Collette Bayou to provide navigation to the east bay area of the Mississippi River delta. Beneficial use of dredged material to develop wetlands was a contract requirement. Height restrictions of 2.5 and 1.5 feet MLG in wetland sites on the east side of the channel and 3.5 feet MLG at bird island sites were specified. In the next four maintenance dredging events, bird islands were the primary use of dredged material. Material was restricted to a height of 3.5 feet MLG and the size of the islands were limited to five acres. Inspection of sites in 1984 indicated the need to adjust height requirements to achieve the wetland and bird island development goals. The restrictions were revised to a maximum height of 6.0 feet MLG in wetland sites with a final settled height of 2.5 feet MLG. The maximum height of dredged material placed on bird islands was revised to 8.0 feet MLG with a final settled height of 5.0 feet MLG.

In 1989 following a site inspection of the successful manmade wetlands on the east site of the channel, wetland development on the west commenced with the same height restrictions. In 1991, the maximum height for wetland development was revised to 4.0 feet MLG. In 1992 a new wetland disposal technique was incorporated into the plans. Perpendicular mounds were constructed outward from the channel followed by placement between two perpendicular mounds. In 1992 the wetland height restriction was revised to 3.5 feet MLG. The largest increase in acres of habitat occurred between 1992 and 1994. The increase is attributed to the perpendicular mound technique. In 1995 the dredged material height for bird islands was revised to a maximum height of 7.0 feet MLG.

Since the initial construction of the navigation channel through 1994 and with a limited quantity of dredged material (700,000 to 900,000 cubic yards annually), over 542 acres of habitat have been created. Habitat includes marsh, shrub/scrub, bare land and beach. Seventy-six species of salt and fresh water plants have been documented. The bird islands at Baptiste Collette have been nominated as a United States Important Bird Area because it provides essential habitat to significant numbers of breeding Caspian and gull-billed terns and roosting pelicans. Baptiste Collette is a diverse project which spans from the infancy in using dredged material for wetland development to the present. It is an example of the evolution of beneficial use from trial and error dredged material placement in 1976 to placement based on scientific data gathered through the implementation of a Beneficial Use of Dredged Material Monitoring Program with Louisiana State University, Baton Rouge in 1993.

Sources of information for this presentation came from Corps dredging contracts and files, the New Orleans District Beneficial Use of Dredged Material Monitoring Program, 1995 Annual Report, and Louisiana State University Coastal Studies Institute at Baton Rouge, LA.

DESIGN AND CONSTRUCTION OF BREAKWATERS/SHORE PROTECTION FOR CRITICAL MARSH HABITAT USING STACKED GEOTEXTILE TUBES

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The purpose of this presentation is to (1) describe the geotechnical investigations and design process for a single and "stacked" geotextile tube shore protection project, (2) present and discuss observations of the construction (to occur during May and June of 1997) and (3) list additional concerns to be addressed in future planned test construction projects.

The purpose of this test construction is to verify the constructibility and functional performance of a basic design for approximately 2.5 miles of breakwater/shore protection and approximately 25 miles of containment structure for dredged material. The dredged material is to be used in the construction of 1,600 acres of marsh habitat, in accordance with the Gulf Intracoastal Waterway (GIWW) long term Dredged Material Management Plan (DMMP).

The location of the project, on the GIWW, is north of Corpus Christi, Texas, adjacent to the Aransas National Wildlife Refuge (ANWR). Wind-driven waves within the GIWW, and effects of barge wake have caused erosion of the marsh areas in the refuge, the winter habitat for the endangered Whooping Crane. Much of the shoreline has been protected with articulated mat; however, at the project location, Sundown Bay separates the GIWW from the shoreline. Through coordination with US Fish and Wildlife Service (FWS), and other resource agencies, it was agreed that at this location, a breakwater would be most beneficial to the environment since it would both protect the shore from erosion and encourage the development of seagrass in the area behind the breakwater.

Several options were considered, including stone, and earth fill covered with articulated mats. The primary design concern was the soft foundation at the site. It was decided that a design using geotextile tubes could possibly be supported by the poor foundation, and that the design would be cost effective compared to other options. Also, it has been shown that oysters readily attach to the tubes in this area. Although the district has considerable experience with construction of sand-filled geotextile tubes (as discussed in a presentation by McLellan and Maurer in another session), the proposed design, and foundation conditions differ considerably from previous construction. Therefore, it was decided to construct one or more test projects to validate the design and constructibility prior to attempting to build the entire breakwater and begin construction of the Beneficial Use of Dredged Material (BUDM) marsh restoration contained in the DMMP.

The first scheduled test project includes (1) the placement of one 750-foot long, sand filled, 16-foot circumference, geotextile tube, (2) the placement of three "stacked" 500-foot long, sand- filled geotextile tubes, with two parallel tubes as the base and the other placed atop the first two and (3) placement of the three tube configuration described above, but filling the tubes with grout. Foundation conditions at the site generally consist of ten feet of soft to very soft clayey, silty sand, interbedded with thin layers of shell hash.

A considerable amount of foundation investigation work was undertaken to determine the location along the bay with the weakest foundation, which was the desired location for this test project. This proved to be more difficult than was expected. Shallow water limited access to the area. A conventional core drilling rig obtained disturbed samples with a split spoon sampler, but no strength information since undisturbed samples could not be retrieved and the top 10 feet of material could not support the drill stem. Precise information was obtained from electronic CPT tests performed at locations throughout the general area, (as described in WES Report, Cone Penetration Test (CPT) Over-Water Field Investigation and Data Evaluation for Sites along the Gulf Intracoastal Waterway, adjacent to the Aransas National Wildlife Refuge, near Rockport, Texas) but none of the tests were at the test project site. Therefore, the design was based primarily on shear strengths derived from penetration resistance readings taken with a proving ring, using a one square inch standard cone. Readings were taken at depth intervals of 0.25 feet to accurately record the layered nature of the stratigraphy. Once the test site (having the worst foundation) was located, investigations were performed every 100 feet along the proposed centerline of each tube. The cone was pushed to refusal at all locations. The cone results were supplemented with data from an 8 inch hand vane shear test performed at selected depths. Finally, physical samples of material were taken at various depths using PVC pipe, and physical properties and material classification determined.

The required widths of the tubes were calculated based on the Terzaghi bearing capacity equation, using undrained shear strengths determined as described above, using a factor-of-safety of 1.3. The target elevations of the tubes was set at the estimated mean high water elevation of +1.9 Mean Low Tide (MLT). The WES computer program GEOCOPS was used to determine tensile stress in the geotextile tubes during filling, and predict the shape of the filled tubes. A fabric strength of 1000 psi was specified for all tubes. A polyester material is expected to be proposed for the tube fabric. A seam strength of 180 psi was specified for the scour pad seams, as a result of previous seam failures. All other specifications were generally typical of manufacturer recommendations.

Monitoring at the site during construction will consist of elevation profile surveys along the tube centerlines, to be performed before construction, immediately after tube filling, and periodically thereafter, measurements of pressure at the inlet of the tubes during filling, sampling and determination of grain-size distribution of material selected by the contractor to fill the tubes, sampling and determination of grain size distribution of material retained in the tubes and general observation and video recording of the construction process. Expected lessons learned include: (1) problems in stacking sand-filled or grout filled tubes; (2) effectiveness of filling tubes with very fine sand, containing large percentages of silt and clay; (3) constructibility problems associated with filling tubes with grout; and (4) foundation behavior for each of the three designs.

Long-term monitoring will include measuring settlement both within the tube, and resulting from consolidation of the foundation materials, effectiveness of the scour pads (particularly the size of the anchor tubes, and strength of seams), the capability of the polyester fabric to maintain adequate strength over time in the site environment. Additionally, observations will be made regarding the wave-breaking effectiveness to determine optimum top elevation, effects of barnacles, oysters and other attached biomass.

Based on the results of this test construction, another test construction will be performed during the summer of 1998, to answer further questions. This test will be at a site having considerably weaker foundations than at Sundown Bay, and will focus primarily on applying what we learn at Sundown Bay to accomplish a successful "floating breakwater" design for the very worst foundation locations in the project area. An effective design and construction in these very challenging foundation areas is necessary, both to complete the proposed breakwater and to ensure accomplishment of the proposed marsh restoration, Whooping Crane habitat, included in the long-term DMMP.

FEATURES IN DREDGED MATERIAL SALT MARSHES DUE TO NATURAL EROSION

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Several lessons have been learned from the wetland restoration project adjacent to the Gulf Intracoastal Waterway (GIWW) in West Bay north of Galveston Island, TX. The wetlands were restored on top of dredged material placed within confining dikes to an intertidal elevation in July, 1992. The project was a demonstration of the beneficial use of dredged material by the US Army Engineer District, Galveston (SWG). Monitoring of the project has been conducted by the US Army Engineer Waterways Experiment Station through the sponsorship of SWG and the US Army Corps of Engineers' Wetlands Research Program.

The project was designed to investigate a variety of erosion protection alternatives. An important consideration for the design of the project was that additional wetlands would be restored with each new dredging cycle on the GIWW which is typically every three to five years. Therefore, the erosion protection for each placement only needed to function over that interval. The erosion protection used at the project was documented by McCormick and Davis (1992) and included unprotected earthen dikes with steep and mild slopes, vegetation, coconut fiber mats, geotextile tubes, and a dynamic revetment. We found that the different levels of erosion protection used at the site produced an irregular pattern of erosion along the shoreline. The result is an increased interface between the bay and the wetlands with open water pools, channels, and mudflats.

Material from subsequent dredging operations should be placed adjacent to (in front of) the existing eroded shoreline. Essentially, what is now an irregular vegetation line along the shore would become the interior of an expanded marsh. The interior of the marsh would therefore have a natural-looking pattern of vegetation with pools, channels, and mudflats included. To construct wetlands with those characteristics would be extremely difficult. But by staging the development of wetlands and allowing the sea to shape the marshes, a higher quality marsh can be obtained. Since less expensive erosion protection is recommended, costs can be saved on the development of a large wetlands restoration project.

McCormick, J.W. and Davis, J.E., 1992 (June). "Erosion Control with Dredged Material at West Bay, TX," Wetlands, Proceedings of the 13th Annual Conference. Society of Wetland Scientists, New Orleans, LA.

TECHNICAL SESSION 7: Poplar Island

Jeffrey McKee, PE, Chair

POPLAR ISLAND RESTORATION PROJECT: PROJECT OBJECTIVES AND ORGANIZATION

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As with any port whose channels require deepening or maintenance dredging, the success of Port of Baltimore depends in part on the implementation of a cost-effective placement site for dredged material. The Port of Baltimore planned and developed the Hart-Miller Island dredged material placement site during the 1980's and this site has served as an innovative example in dredged material management. As the capacity of Hart-Miller Island has diminished over time, it became necessary to develop a new site for clean Port of Baltimore sediments. The new site eventually became the Poplar Island Restoration Project, located in Chesapeake Bay off the Eastern Shore.

This paper provides an overview of the process and rationale that led to the selection of the Poplar Island site. The paper will emphasize the agency/public coordination and consensus-building processes that identified the location of the site and the nature of and rationale for the island restoration. The paper will also elaborate on the goals and philosophy of the port in its endeavors to develop environmentally beneficial dredged material placement sites. This overview paper will serve as a companion to a series of additional presentations following in this session which cover technical issues surrounding the Poplar Island project. The importance of this paper is that serves to summarize the factors that led to development of one of the largest containment island projects in the United States. It will provide attendees of the conference with a good understanding of the efforts required to implement this important dredged material disposal option.

Challenges are both environmental and engineering, as the original Poplar Island has been subjected to massive and persistent erosion over time until less than five acres remain. At the same time, it has provided habitat to a wide diversity of wildlife, especially colonial nesting waterbirds. At the current time, the nesting colonies on the remnant island are temporarily protected by a semi-circle breakwater of sunken barges. The goal is to rebuild Poplar Island using dredged material from the navigation channel. Objectives for the Island include providing a range of habitats (aquatic, wetland, upland, and island) for fish and wildlife.

POPLAR ISLAND RESTORATION PROJECT: PLANNING AND DESIGN ASPECTS

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The Poplar Island Restoration Project is a proposal to restore habitats lost through the erosion of Poplar Island in Chesapeake Bay by the beneficial use of dredged material from the Bay approach channels to the Port of Baltimore. The project is to be carried out under the provisions of the Water Resources Development Act of 1996 and involves restoration of four remnant islands (with a footprint of only five acres) to a pre-erosional 19th Century area of approximately 1100 acres, thereby creating new acreage of aquatic, intertidal wetland, perched wetland, upland, and island habitats for fish and wildlife. The major goals and objectives of this beneficial use site are as follows: (1) optimization of the volumetric capacity of the site for dredged material; (2) preparation of a cost-effective design within available funding; (3) restoration of Poplar Island to its 1847 footprint; (4) creation/restoration of desirable habitats, and (5) design all aspects of the site in an environmentally acceptable manner.

Three alternative alignments (with site areas ranging from 820 to 1340 acres, and dike top elevations ranging from 7 to 20 feet) were considered based on discussions with Maryland Port Administration (MPA), US Army Corps of Engineers (Corps), Maryland Environmental Service (MES), and the Poplar Island Working Group (Gahagan and Bryant Associates, Moffatt and Nichol Engineers, and their associates). Alignment #1 is more or less aligned along the 1847 position of the eastern shoreline of Poplar Island and has an area of 820 acres. Alignment #2 with an area of 1340 acres is an extension of Alignment #1 to the south and east, and fronts on the southern shoreline of Coaches Island. Alignment #3 is more or less in between the other two alignments and has an area of 1100 acres. Several factors were evaluated during the planning phase, including:

(1) water depths (2 to 12 feet)
(2) wind speeds (>90 mph during the 100-yr event)
(3) tidal range (mean of 1.8 feet)
(4) wave action (100-yr wave of 10 feet height and 6 second period)
(5) currents (negligible)
(6) foundation conditions (soft to hard silt clays and sands)
(7) charter oyster bars
(8) location of the remnant islands and Poplar Harbor
(9) 1847 footprint

(10) availability of on-site borrow material

Design analyses considered the following principal aspects of the alternative site layouts:

(1) perimeter dike alignment
(2) capacity and operational life
(3) schedules for site construction
(4) average annual volume of dredged material to be placed
(5) optimized perimeter dike section
(6) construction methodology
(7) access to the site for unloading dredged material
(8) placement of dredged material
(9) habitat development
(10) site monitoring
(11) site management

Perimeter dikes constitute the principal initial cost of the project and were designed to contain fine-grained dredged material placed at the site. Interior dikes were used to separate the wetland and upland cell areas since a large elevation differential will exist between these two types of habitat. It is estimated that depending on the selected site configuration, about 10 to 47 million cubic yards of dredged material will be required for restoring the island. This equates to 6 to 27 years of maintenance volume from the Chesapeake Bay southern approach channels. Further details of the planning and design considerations for this project will be discussed during the presentation.

POPLAR ISLAND RESTORATION PROJECT: COASTAL ENGINEERING ASPECTS

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Poplar Island is one of the success stories regarding the development of a cost-effective and environmentally implementable dredged material placement site for a major United States port. The project involves the artificial re-creation of an eroded island located along the eastern shore of the Chesapeake Bay. This presentation addresses the coastal engineering aspects of the planning and design of the project.

Specific issues addressed in the presentation include: (1) detailed design of the containment dikes with explanation of the optimization design procedures used, (2) physical model testing of the containment structures, (3) construction methodology and costs for the containment structures, and (4) numerical modeling of the impacts of the island development on hydrodynamics, water quality and sedimentation.

POPLAR ISLAND RESTORATION PROJECT: DREDGING ENGINEERING ASPECTS

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The Poplar Island Restoration Project involves restoration of four remnant islands within a footprint of only five acres to a pre-erosional 19th Century area of approximately 1100 acres, thereby restoration acreage of aquatic, intertidal wetland, perched wetland, upland, and island habitats for fish and wildlife. As part of the planning phase of the project, three alternative site alignments with site areas ranging from 820 to 1340 acres, and dike top elevations ranging from 7 to 20 feet were considered. Creation and restoration of desirable fish and wildlife habitats were the primary environmental objectives of the project. Successful habitat development is dependent upon several factors including final elevations of the dredged material, material consolidation, material slopes, tidal range, water quality, and establishment of vegetation. The following were the main dredging engineering issues to be resolved: (1) perimeter dike alignment and material volumes; (2) site access for material placement; (3) site capacity and operational life; (4) habitat development; (5) site monitoring; (6) site management; and (7) construction methodology, schedule and costs.

Perimeter dikes were designed both to contain fine-grained dredged material placed at the site and also to provide protection to the habitats from wave damage, while interior dikes would be used to separate the wetland and upland cell areas (since a large elevation differential will exist between these two types of habitat). A range of dike top elevations from 7 to 20 feet were evaluated. In order to provide access to the site during construction, an access channel was proposed to be constructed. Material from the cannel dredging would be used for dike construction. Site capacity and operational life were developed based on three criteria: (1) volume occupied by dredged material (bulking and consolidation effects); (2) placement rates and lift thickness; and (3) cell areas and cell capacity for various dike elevations. The resulting estimated site capacities ranged from 10 to 47 million cubic yards which equate to about 6 to 27 years of site operational life.

Various habitat development criteria were developed for wetland areas ranging from 50 to 100 percent of the total site area. Site monitoring was estimated based on projected regulatory requirements, while site management needs were developed based on dewatering and crust management plans developed for similar sites. A variety of dredging and placement techniques were evaluated based on the above mentioned unique project requirements. Total site development costs were based on:

(1) evaluation of initial site construction costs, including perimeter dikes, interior dikes, cell spillways, sheetpile bulkhead, construction management, and monitoring before and after construction;

(2) future upland dike raising costs

(3) habitat development costs, including wetland contouring, tidal wetland habitat, and upland habitat; and

(4) annual costs, including management of dredged material placement, habitat management, site maintenance, and site monitoring.

Estimated total site development costs ranged from $59 to $147 million, which translate to approximately $3 to $6 per cubic yard of site capacity. Further details of the dredging engineering aspects of this project will be discussed during the presentation.